Quantitative Evaluations of the Effects of the Seabed Sediments on the Scattering and Propagation of Low to Medium Frequency Acoustic Energy in the Shallow Oceans

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LONG-TERM GOALS

To quantitatively understand the physics of propagation and scattering of low to medium frequency (20-15000 Hz) acoustic wave in shallow waters and seabed sediments.

OBJECTIVES

The first is to quantitatively understand the effects of seabed scattering mechanisms (volume fluctuation, bottom and sub-bottom roughness) on the acoustic propagation and scattering. This includes the effects of poro-elastic properties of the sediments on the propagation of acoustic waves. The secondary objective is the quantitative understanding of the spatial and temporal fluctuations (amplitude and phase coherency) of acoustic wave fields in shallow water.

APPROACH

The monostatic and bistatic scattering from seabed sediments will be measured using our bilinear array in sandy bottom and clay bottom . At the same time the reciprocal transmission of Gold code acoustic signals at center frequency at 5.5 kHz (1023 cycles, three sine waves per cycle) will be made among three stations separated by 5 to 20 km to study the effect of bottom sediments, spatial and temporal fluctuations within the water column. Inversely, these acoustic data will be inverted to extract sediment properties and water column physical properties of internal waves, tides and fronts. These measurements will be compared with the low frequency scattering and propagation measurements by Dr. Kazi Ohta, of Japan Defense Agency, Dr. Altan Turgut of NRL, and Dr. George Frisk of WHOI.

WORK COMPLETED

Three autonomous acoustic reciprocal transmitters have been built and being tested for the SWAT October 2000 experiment. One of them is also equipped with 32-channel bilinear array for monostatic and bistatic scattering measurements.

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RESULTS

Monostatic scattering and bistatic scattering data at 15 kHz from a sandy bottom and a clay bottom are critically compared. It was learned that at small grazing angle (less than 15 degree) the bistatic scattering is stronger than the monostatic scattering regardless the sediment type (Day and Yamamoto, 2000; Yamamoto and Sun, 2000). The monostatic scattering at large grazing angles from sediments is mainly from the sediment volume (Rogers and Yamamoto, 1999; Day and Yamamoto, 1999).

The apparent attenuation within the nearsurface sediments at medium to high frequency is due to the Biot mechanism and the scattering from the velocity and density fluctuation within sediment volume according to the velocity and attenuation measurements.(Yamamoto, INPRESS)

IMPACT/APPLICATIONS

Monostatic scattering measurements from sediments closely follows the anisotropic volume velocity and density fluctuation represented by Yamamoto (1996).

The permeability structure within the near surface sediments was imaged for the first time by crosswell tomography (Yamamoto, I N PRESS).

TRANSITIONS

The Yamamoto model of anisotropic velocity and density fluctuations is widely used in 6.2 and 6.3 community for scattering modeling.

RELATED PROJECTS

We collaborate with Dr. Kazi Ohta, of Japan Defense Agency, Dr. Altan Turgut of NRL, and Dr. George Frisk of WHOI.on the research of mutual interest on bottom sediment characterization, scattering and propagation.

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1. Day, C. M. and Yamamoto, T., "Low graging angle bistatic sea floor scattering on the Florida Atlantic coastal shelf," J. Acoust. Soc. Am., **106 (4)**, pp1744-1754.

2. Rogers, A.K., and Yamamoto, T., "Analysis of high-frequency acoustic scattering data measured in the shallow waters of the Florida Strait, J. Acoust. Soc. Am., **106 (5)**, pp2469-2480.

3. Yamamoto, T, "Imaging the permeability structure within the near-surface sediments by acoustic crosswell tomography," J. Applied Geophysics [IN PRESS].

4. Yamamoto,T. and Sun, H., "Critical comparisions of the measured forward scattering from a clay bottom and a sandy bottom.", Paper #5aUW5, 139th Meeting: Acoustical Society of America, Spring Meeting 2000.

PUBLICATIONS

1. Day, C. M. and Yamamoto, T., "Low graging angle bistatic sea floor scattering on the Florida Atlantic coastal shelf," J. Acoust. Soc. Am., **106 (4)**, pp1744-1754.

2. Rogers, A.K., and Yamamoto, T., "Analysis of high-frequency acoustic scattering data measured in the shallow waters of the Florida Strait, J. Acoust. Soc. Am., **106 (5)**, pp2469-2480.

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PATENTS

Yamamoto, T., #6,061,3000 May 9. 2000. "Method of Imaging the Permeability and Fluid Content Structure within Sediment."